LhARA: Capture Meeting

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Sampled Beam Tracking

- Sampled results from Smilei simulations using a 4 micron focal size
- Process:
  - Beam tracked for 5 cm in drift space with BDSIM (no space charge)
  - Further tracked through 5 cm of vacuum nozzle with GPT (with space charge)
  - Tracked in BDSIM through the rest of Stage 1 (no space charge)

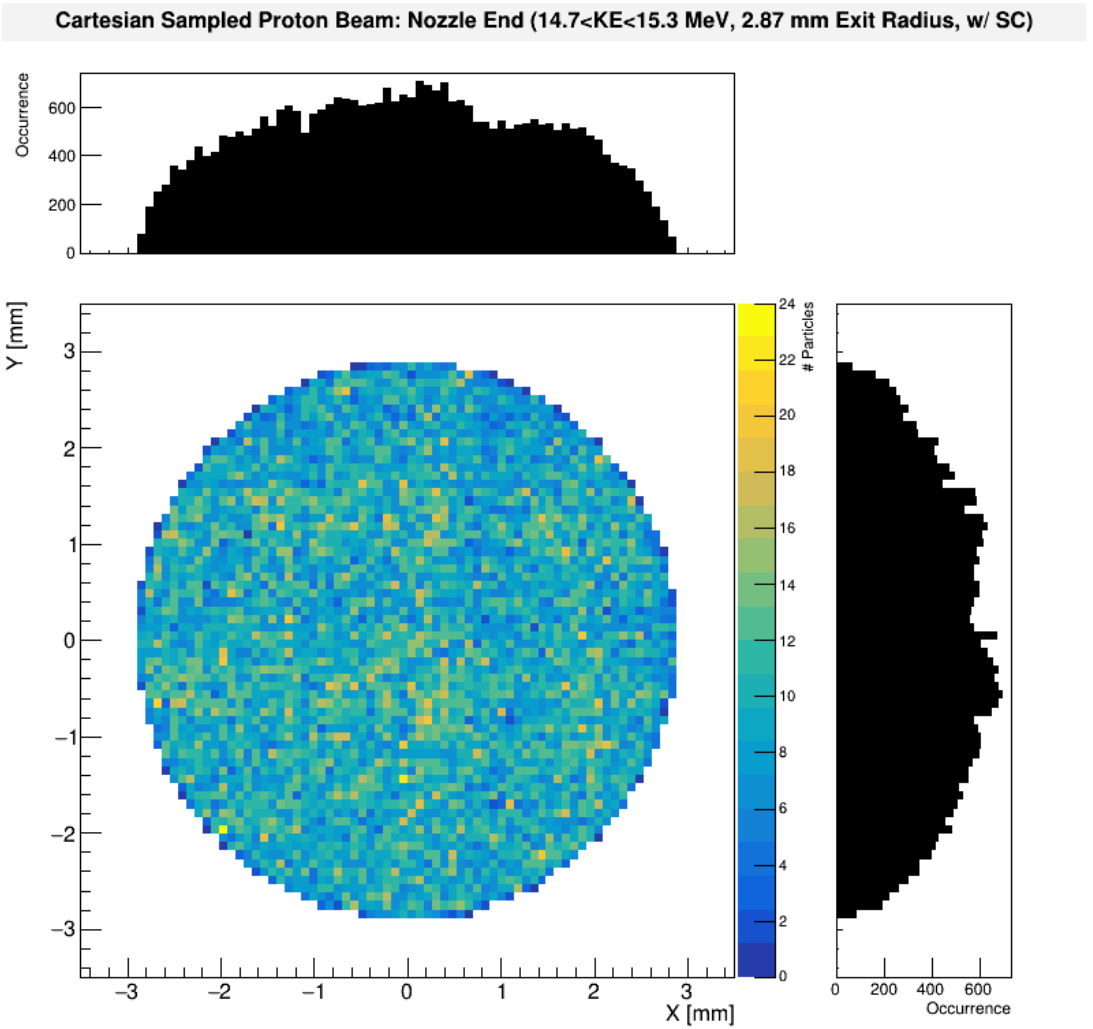
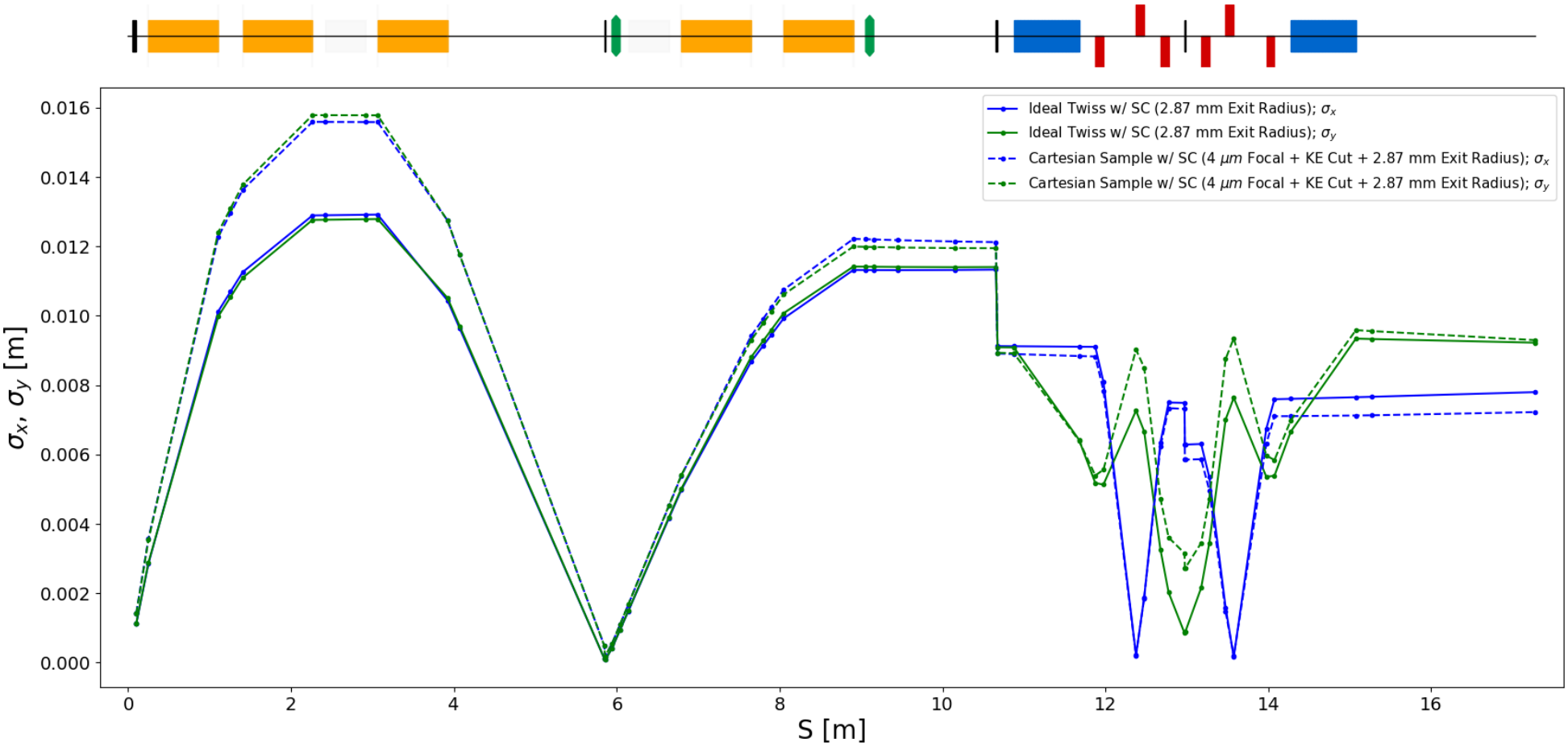


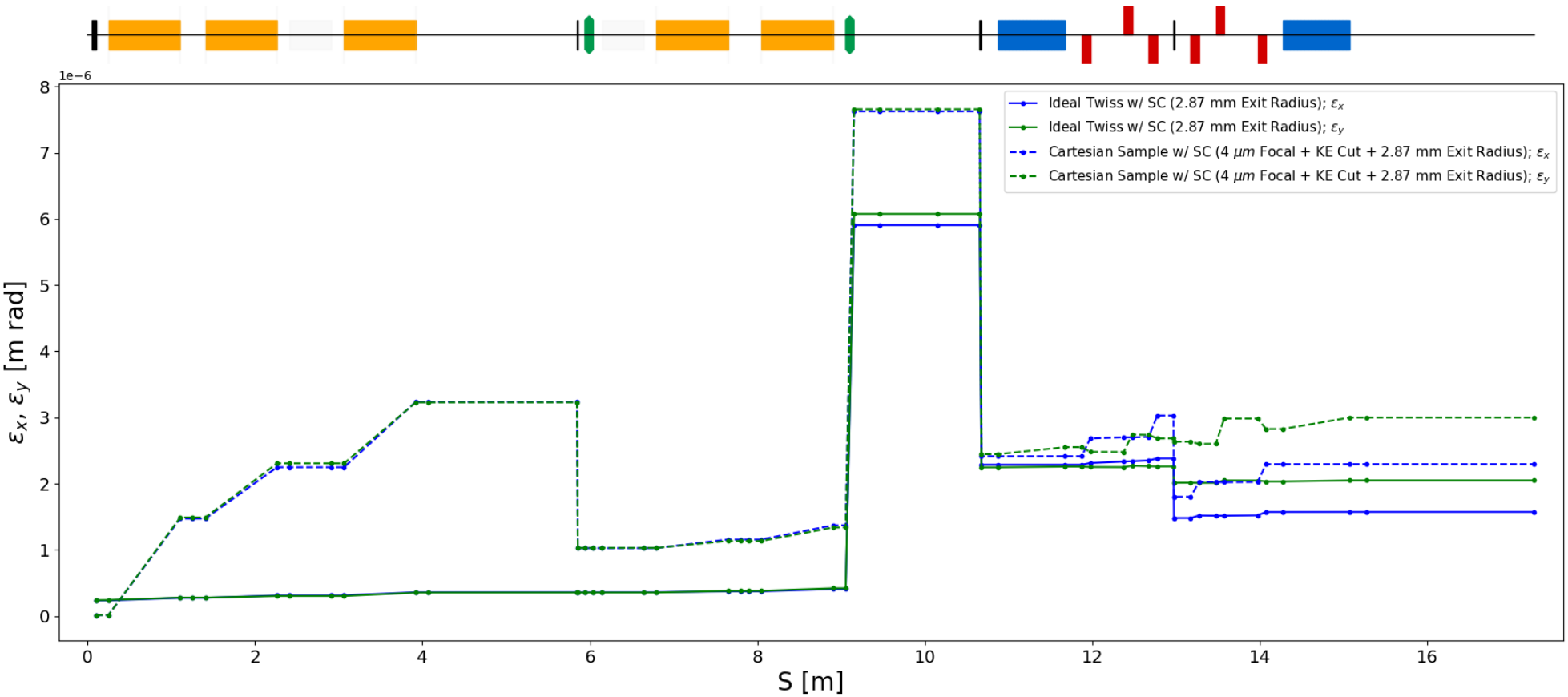
Figure: 2D positional plot of beam at exit of vacuum nozzle (4 μm focal spot).

Beam Size Evolution Comparison against Ideal Twiss Beam



- There is an initial discrepancy in beam size.

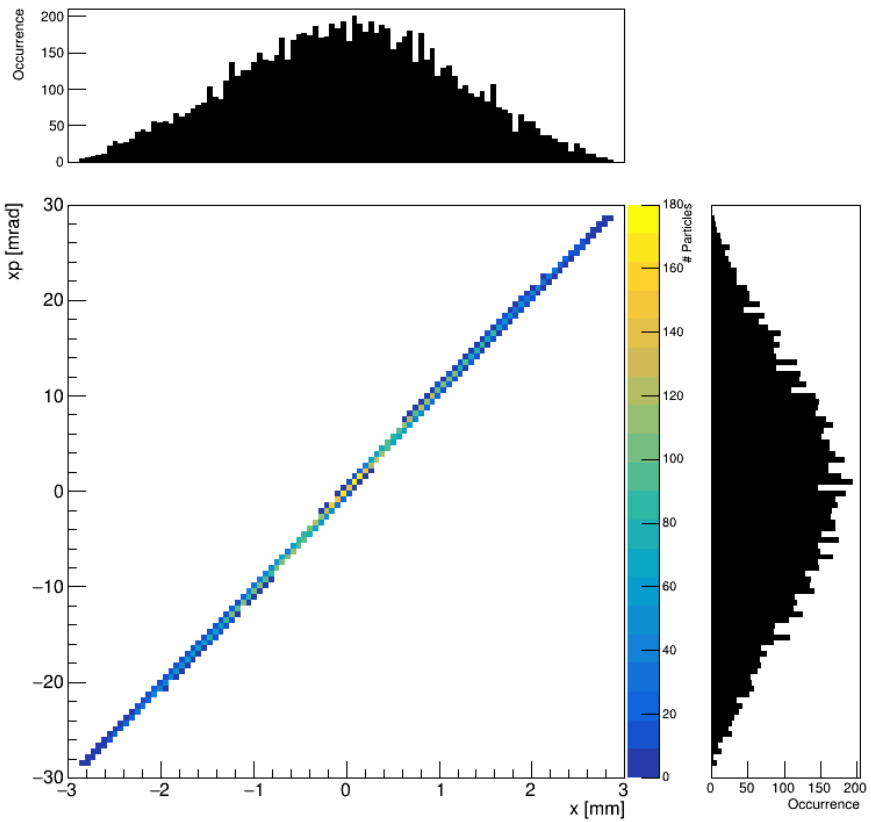
Beam Emittance Evolution Comparison against Ideal Twiss Beam



- Different beam emittance, starts small but then grows and changes throughout beamline.

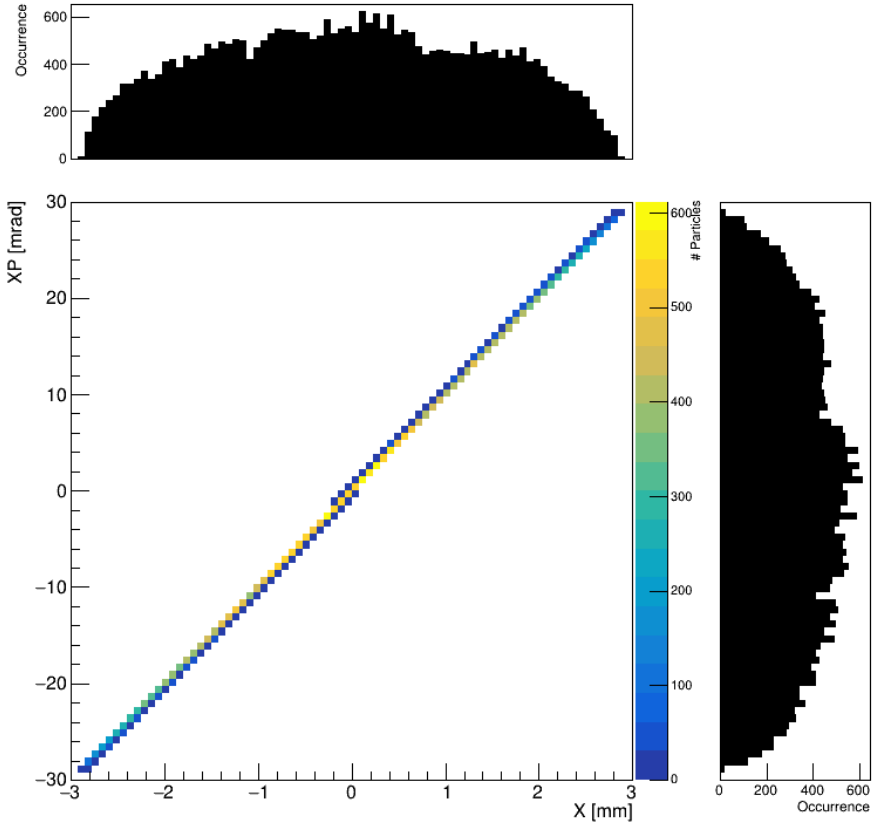
Fitted Twiss Parameters at Exit to Nozzle

Ideal Beam: Nozzle End (w/ SC)



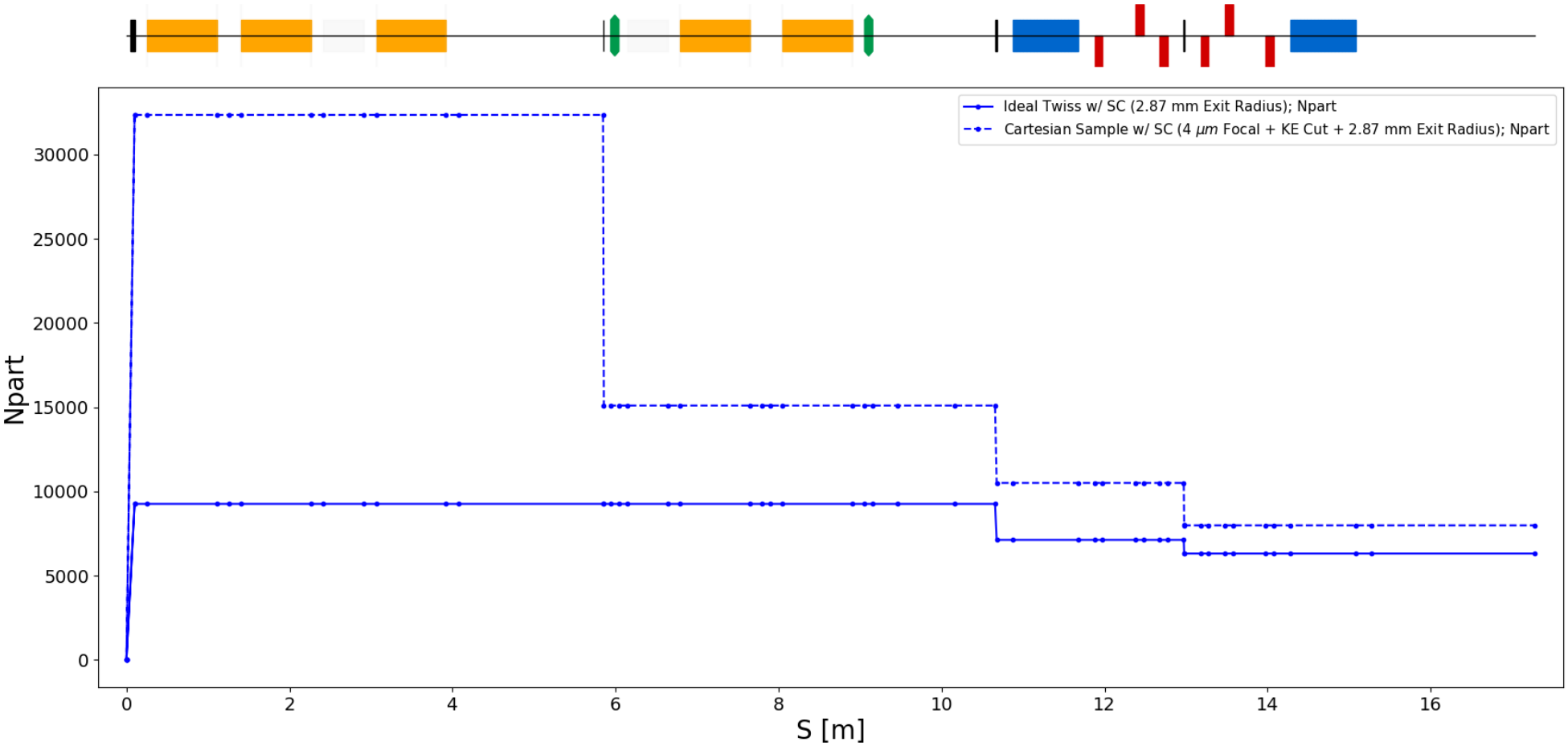
β_x [m]	5.4 ± 0.1
α_x	-56.0 ± 0.4
ϵ_x [m rad]	$2.3 \times 10^{-7} \pm (2.6 \times 10^{-9})$
β_y [m]	5.3 ± 0.1
α_y	-55.2 ± 0.4
ϵ_y [m rad]	$2.4 \times 10^{-7} \pm (2.7 \times 10^{-9})$

Cartesian Sampled Proton Beam: Nozzle End (14.7<KE<15.3 MeV, 2.87 mm Exit Radius, w/ SC)

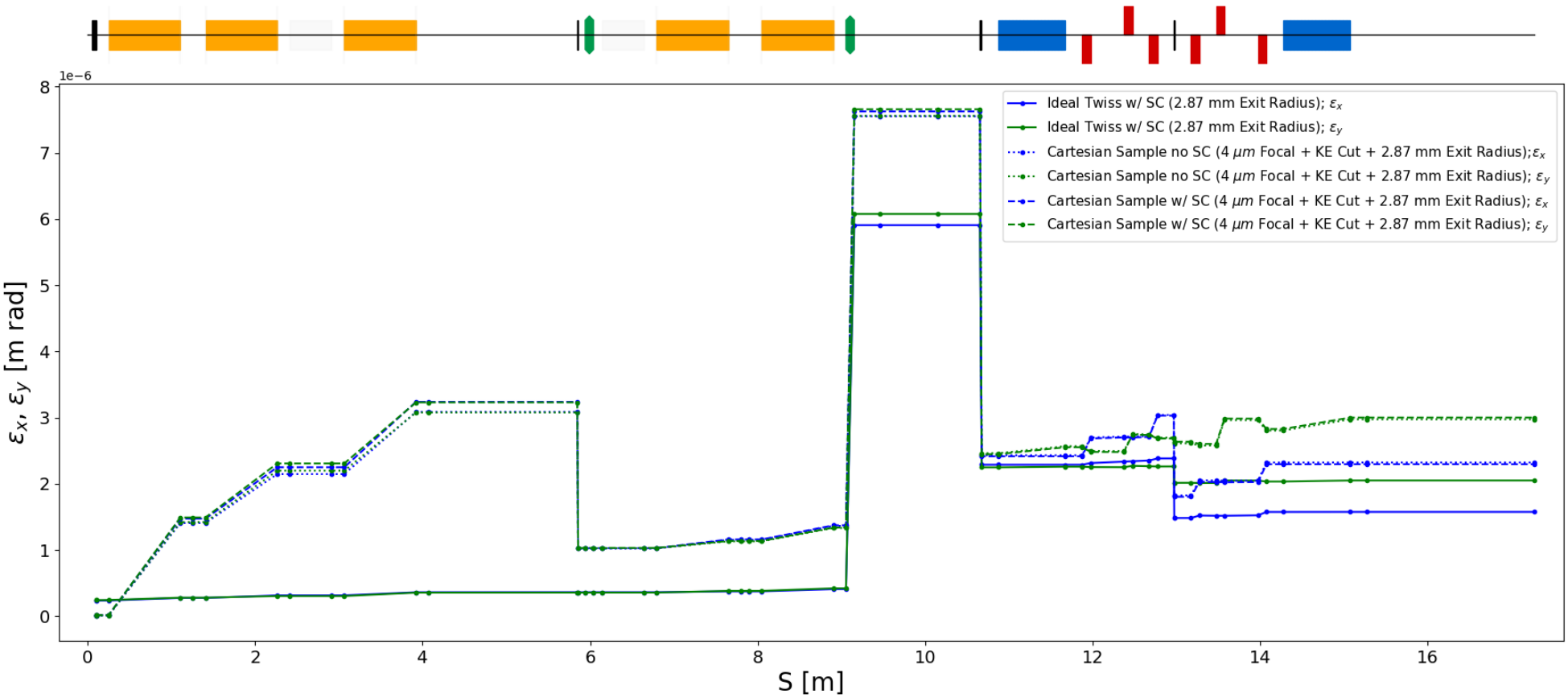


β_x [m]	145.4 ± 0.7
α_x	-1458.6 ± 6.8
ϵ_x [m rad]	$1.4 \times 10^{-8} \pm (8.0 \times 10^{-11})$
β_y [m]	149.1 ± 0.8
α_y	-1496.3 ± 8.4
ϵ_y [m rad]	$1.3 \times 10^{-8} \pm (8.3 \times 10^{-11})$

Beam Losses

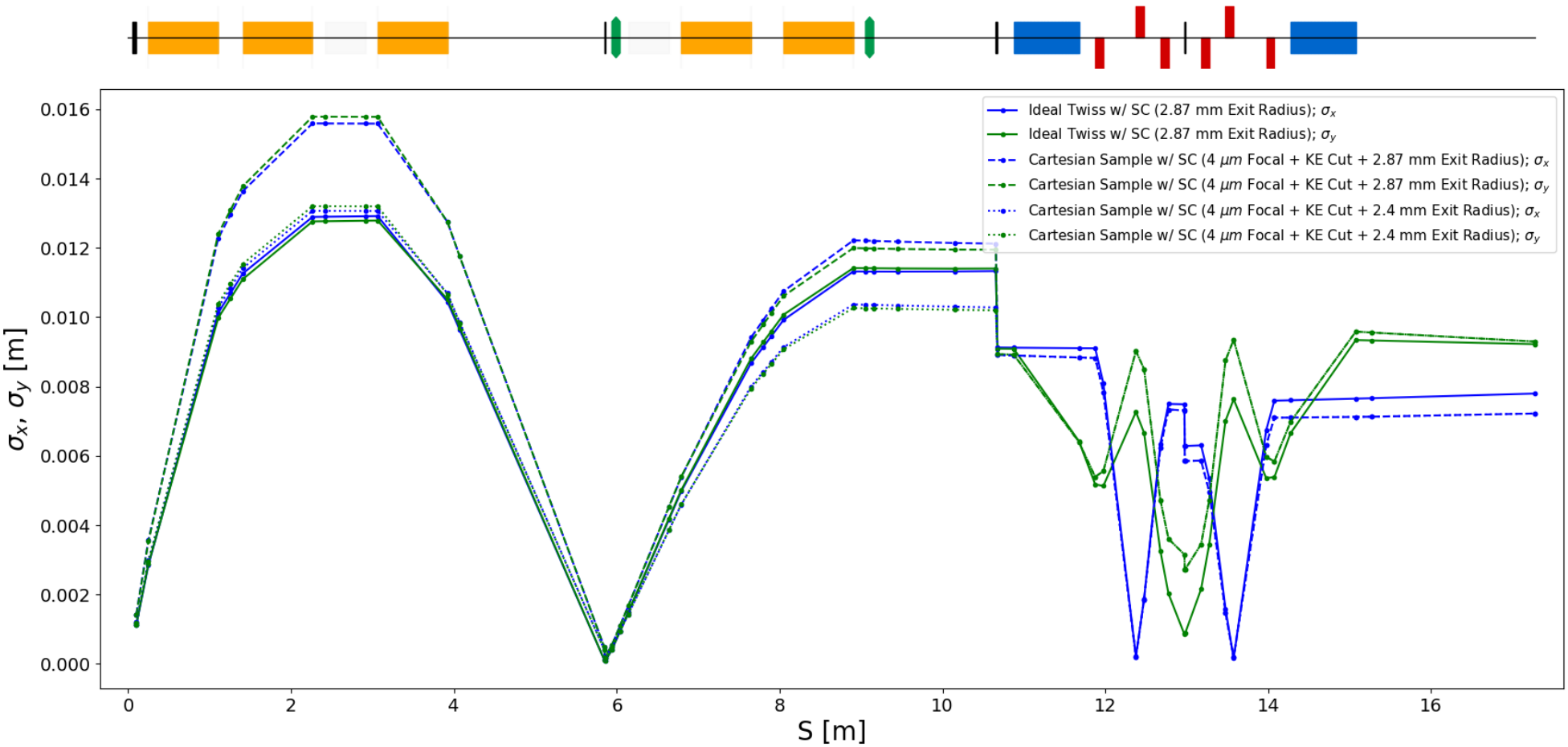

Ideal Twiss w/ SC (2.87 mm Exit Radius); Npart
Cartesian Sample w/ SC (4 μm Focal + KE Cut + 2.87 mm Exit Radius); Npart
Npart
S [m]
0
5000
10000
15000
20000
25000
30000
0
2
4
6
8
10
12
14
16

No SC v SC – Emittance Comparison



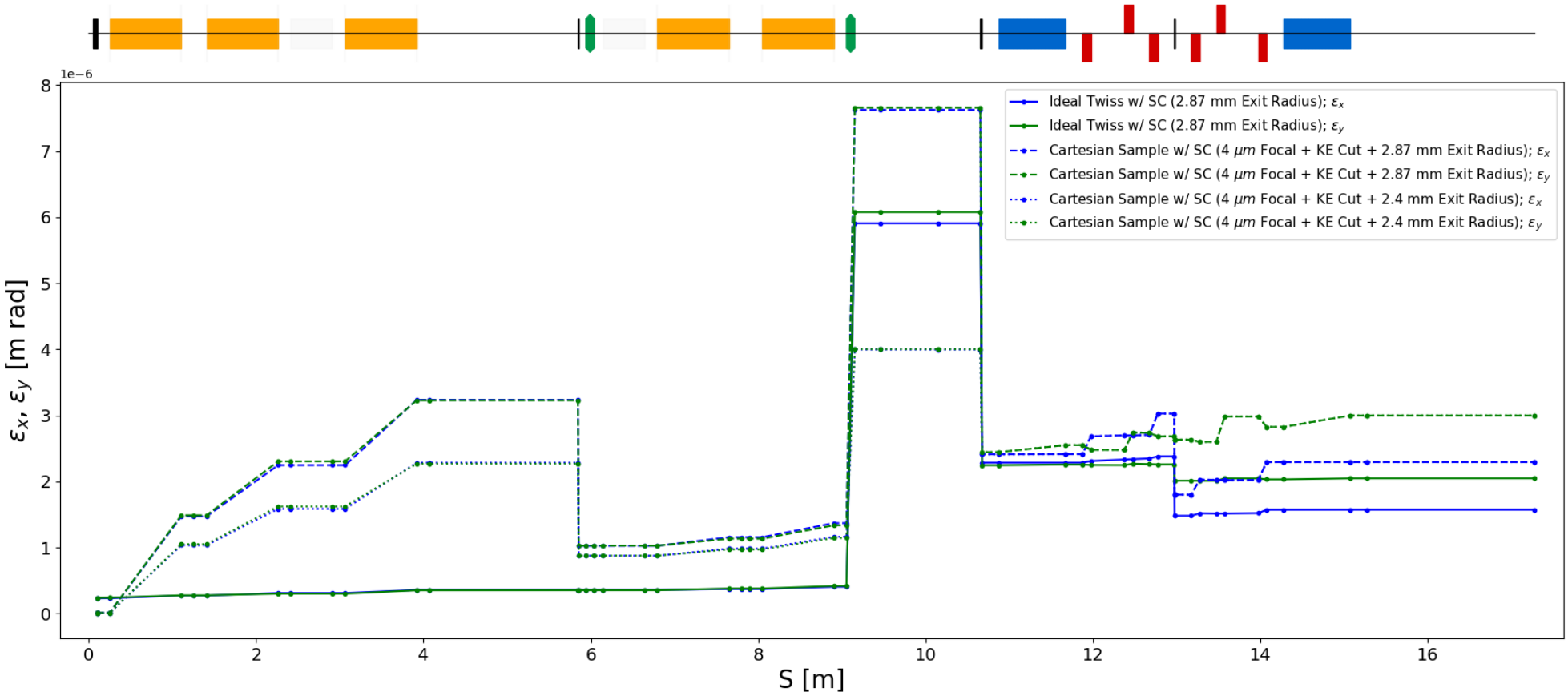
- Dotted line is no space charge
- Dashed line includes space charge
- Solid line is ideal beam with space charge

Decreasing Exit Nozzle Radius



- Reducing exit radius to 2.4 mm (dotted plot), brings beam size evolution slightly closer to ideal beam.

Decreasing Exit Nozzle Radius



- Emittance smaller than beam with 2.87 mm exit radius, but same emittance at end station.